BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problems Mailbox.

(12) UK Patent Application (19) GB (11) 2 075 194 A

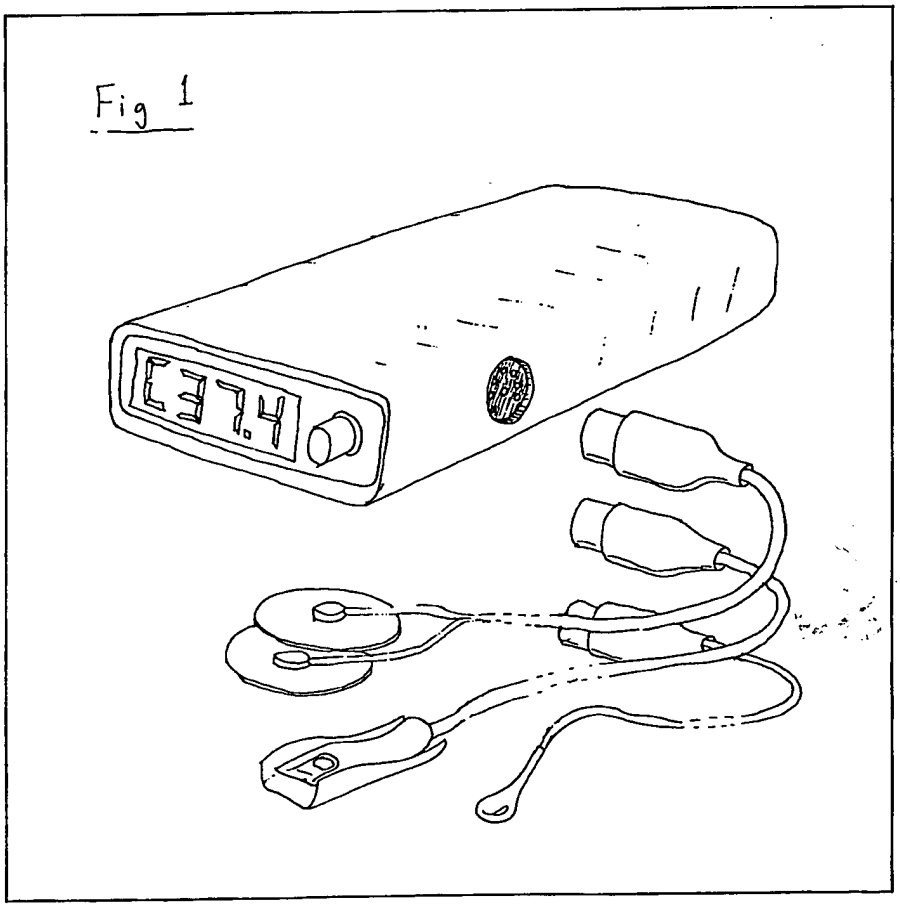
(21) Application No 8014156
(22) Date of filing 30 Apr 1980
(43) Application published
11 Nov 1981
(51) INT CL³
A61B 5/00
(52) Domestic classification
G1N 19B2P 30P1 30P2
30P8
(56) Documents cited
GB 1158629
GB 338251
US 3934267
(58) Field of search
G1N
H2E
(71) Applicants
Nicolas Simon Sancha,
8 Melbury Road flat 5,
London,
W14 8LR.
(72) Inventors
Nicolas Simon Sancha

(54) **Portable heart rate, pulse rate or temperature monitor**

(57) A portable heart rate, pulse rate or temperature monitor, providing an L.C.D. has a single 8 pin input socket into which are plugged either an e.c.g. probe having two electrodes, or pulse meter probe or temperature probe.

The 8 pins on each probe plug are connected so that, when inserted, that probe is identified calling up the correct read out of beats per minute or degrees centigrade as well as altering the internal circuit (eliminating the need for any manual switching controls). The same socket is used for charging the batteries from an external source and the absence of any inserted plug will cause the internal circuitry to display an indication of the battery condition on the L.C.D..

Fig 1



GB 2 075 194 A

Fig 1

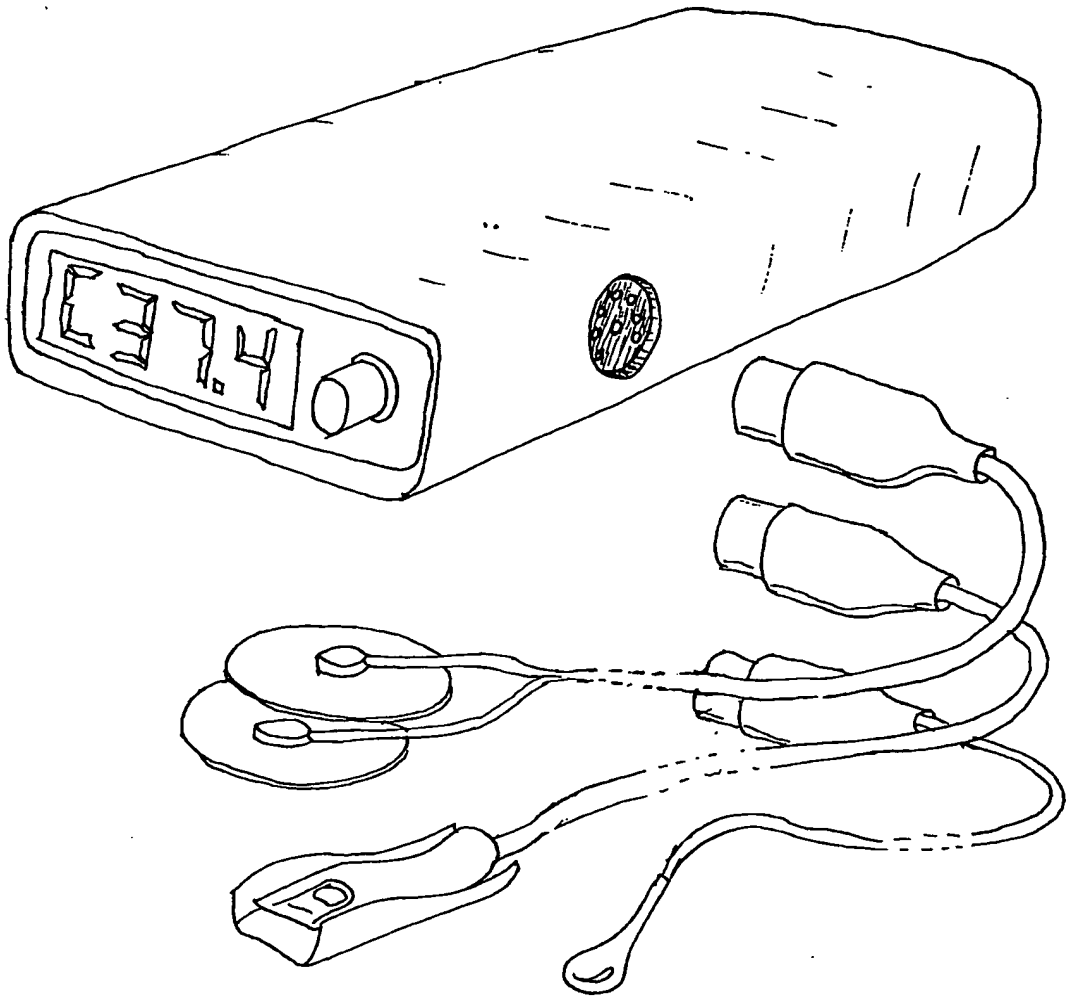


Fig 2

Fig 3

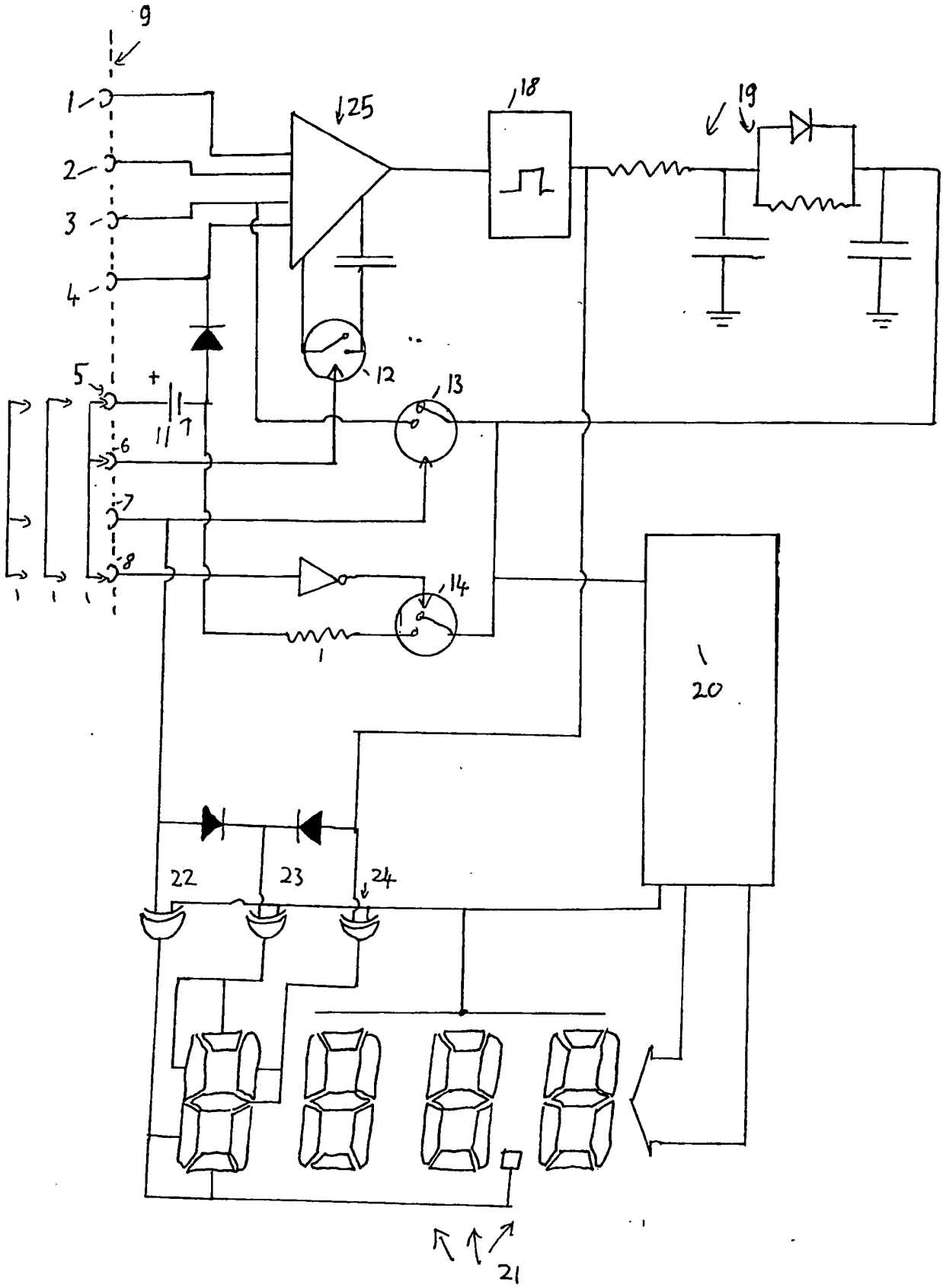


Fig 4

SPECIFICATION

A portable heart rate, pulse rate and temperature monitor

This invention relates to a fully portable heart rate, pulse rate and temperature monitor. In its preferred form this invention relates to a small battery operated unit having a low power digital liquid crystal display and provides a single input socket into which are plugged either two electrodes or, pulse pick up or temperature probe. Ease of use is aided by the way the various probes automatically call up the correct read-out of degrees centigrade or beats per minute as well as altering the internal circuit to accommodate that probe, thus eliminating the need for any switching controls.

In hospitals today conditions arise that do not warrant the expense of large sophisticated monitoring equipment, for instance in minor operations, and such a simple apparatus as described above is quite suitable for these occasions as well as many others and would find its place as a pocket tool for the Anaesthetist, Doctor, General Practitioner and Nurse. The applications for this apparatus would span from checking peripheral circulation and heart rate during an operation to allowing patients to reliably and accurately measure their own temperature and pulse. Even with large scale integrated circuits it is still difficult to manufacture such a small monitor, whereas the production model easily fitted into an overall pocket and represents the state of the art in the miniaturisation of such instruments.

As yet medical equipment for monitoring both heart rate, pulse rate and temperature are bulky, very expensive, sophisticated and require an experienced person to operate them. The specification of British Patent No. 1470121 proposes such a complex system that performs detailed analysis on collected data, of pulse, temperature and respiration. The nearest approach to an all-round pocket monitor is a pulse meter in the form of a watch as proposed in the British Patent No.'s 1312107 and 1524413 as well as the specification of United States Patent No. 3742937.

No. 1312107 proposes a pulse meter that counted the cycles of a known stable frequency between each or a number of heart beats. This is really an indication of the interval between beats and is quite the reverse of the current medical trend.

No.'s 1524413 and 3742937 proposes a pulse meter that counts the number of beats over a set period of time, usually 15 seconds, giving a true indication of the average pulse rate at the end of the counting interval. The dissadvantage with this method is that the Doctor must wait this interval for the display to update. This means that should any sudden change in pulse rate occur, at worst case 15 seconds could elapse before the display is updated to alert the observer.

According to the present invention an apparatus is proposed that, in one small battery operated unit, it can measure heart rate from two skin electrodes, pulse rate from finger or ear pick up and temperature the device is the way in which it can accept each type of probe without need for the user to switch any controls.

The probes are connected to the device by way of an 8 pin plug that fits into an 8 pin socket on the said device. 4 of these 8 pins carry the input signal currents from the probes to particular parts within the electronic circuit whilst 3 of the remaining 4 pins are connected to the gate terminals of bilateral switches. The last of the 8 pins is connected to the most positive side of the battery.

A bilateral switch is a three terminal device where the resistance between two of the terminals is dependent on the voltage applied to the third called a gate terminal. Applying either an extreme low or high voltage to the gate terminal allows the bilateral switch to be used as a complete switch to connect or disconnect parts of one circuit to another.

Within each probe plug, one or two of the three pins, that would be connected to the gate terminals of the bilateral switches if the plug were inserted into the monitor, are soldered to the "would be" positive side of the battery pin. So that when the plug of that particular probe is inserted, the gate terminals of a particular bilateral switch or switches will be pulled high, switching into the circuit a new component resulting in the characteristic of the circuit being fundamentally altered. When no plug is inserted the lack of any link being established between one of these 3 controlling pins and the positive supply results in a number corresponding to the battery condition to be displayed. This is done by having the wire connecting the gate of one bilateral switch to the 8 pin socket pass through an inverter, so that when no plug is inserted this switch is conducting and allows a small portion of the battery voltage to be measured by the display circuit.

The 8 pin socket can also be used for recharging the battery by connecting a charger or source to two pins of an 8 pin plug, such that when inserted in to the monitor current can flow into the device through the positive side of the battery pin and return via a particular input line that has a diode connecting it to the negative side of the battery.

During normal operation this diode is reversed biased and has no effect on the input circuit yet when on charging and the instrument is turned off this diode is forced into forward conduction letting current flow back into the battery.

The low power liquid crystal display (L.C.D.) in this apparatus is driven by a single chip digital voltmeter integrated circuit. This will display the relative value of a voltage at its input compared with a reference voltage. The advantage of using a digital voltmeter chip in this monitor instead of a counter chip, as suggested in the patents mentioned previously, is that it is most suitable for measuring the voltage of a thermistor and hence display a value of temperature. Heart or pulse rate can be displayed by measuring the voltage develped across a low pass second order filter that is being fed by a monostable oscillator triggered by each heart beat. In this arrangement the digital voltmeter will display, updating each second, a moving average of pulse or heart rate over a period

of the second order filter.

The advantage of this method is that a slow change in rate is visible in a few seconds where as in the previous patent specifications 15 seconds may elapse before the first or a new heart rate is displayed.

A second order filter can be made by following one resistor/capacitor low pass filter by another of silimar time constant. An improvement can be made by including in the second low pass filter a diode in parallel with the resistor. The result is that when a pulse or heart rate is first taken the diode is forced into forward conduction and reducing the time constant of this second low pass filter until its output has reached 80% of its steady state value, whereupon the voltage across the diode is insufficient to cause significant current to flow. This second filter reverts to its normal long time constant providing a stable voltage that is proportional to heart or pulse rate. This is advantageous to doctors wishing to have a quick value of a patients pulse rate without having to wait, as well as providing fast response to conditions of onset of rapid heart rate such as tachicardias.

The digital voltmeter chip controls 3 digits of the liquid crystal whilst the fourth digit is made, by the use of exclusive/or gates, to indicate the units by displaying a "C", as well as a decimal point, for temperature and a small "o" that flashes up on each heart beat when measuring pulse or heart rate.

L.C.D. is driven by applying an alternating square wave voltage to the back plane of the display and an equal, though 180 degrees out of phase voltage, to the segment. 3 exclusive/or gates are used. The first drives those segments used only in displaying a "C", the second drives those segments used only in displaying the small "o". The third those segments used in both "C" and "O".

In each case one of the pair of inputs to each exclusive/or gate is driven by the back plane of the L.C.D. whilst the other of the first exclusive/or gate is driven by the gate of that bilateral switch being turned on by the temperature probe plug. And the second input to the second exclusive/or gate is driven by the monostable mentioned earlier. Finally the second input of the third exclusive/or gate is driven by both the monostable and the bilateral switch gate mentioned just above.

The invention will further be described by way of example, with reference to the accompanying drawings, in which;

Figure 1 shows a perspective view of the apparatus with the three probes, each of which has its own plug.

Figure 2 shows the "C" as displayed on the fourth digit when the temperature probe is being used.

Figure 3 shows the small "o" as displayed on the fourth digit for a short period of time imediately after each heart or pulse beat has been detected.

Figure 4 shows a simplifyed scchematic diagram of the apparatus.

With reference to Figure 4, the first four pins 1,2,3 and 4, of the eight pin socket 9, are used to carry the input signal currents from either the electrodes, pulse pick up or temperature sensor, to the input processing circuit.

Pin 5 is connected to the positive side of battery 11, and the last three pins, 6,7 and 8 are connected, one via an inverter, to the bilateral switches, 12,13 and 14. When either of the plugs, with connections as represented by 15,16 and 17, are inserted, diferent combinations of bilateral switches will be turned on.

The input processing circuit 25 whose characteristic is changed by the closing of bilateral switch 12, triggers the monostable 18 whose out put feeds both the low pass filter 19 and the exclusive/or gates 23 and 24. These gates generate the flashing "o" on the L.C.D. as in Figure 3. The output of this low pass filter feeds the digital voltmeter 20 which displays the result on the L.C.D. 21. Because the resisters in this low pass filter are so very high as compared with the on resistance of the bilateral switches, the switches 13 and 14 can switch in either the voltage across the temperature probe or a portion of the battery voltage to the digital voltmeter.

A "C" as in Figure 2 is displayed on the L.C.D. by connecting the inputs of the exclusive/or gates, 22 and 23, to the gate terminal of the bilateral switch 13. So that when the plug of the temperature probe is inserted the inputs to these gates 22,23 and 13 are all pulled high together.

Recharging the battery is achieved by connecting a source or charger unit to pins 4 and 5. In this arrangement the diode, 25, becomes forward biassed allowing current to flow back into the battery.

The ease of use of this apparatus allows it to be used by an untrained person in the operating theatre, ward, athletic training, and in the homes of people suffering from heart disease.

CLAIMS

1. An apparatus to monitor and display heart rate, pulse rate and temperature comprising, within a pocket sized housing, electronic circuitry, L.C.D. (Liquid Crystal Display) and a single 8 pin input socket into which are plugged either two electrodes, pulse pick up or temperature probe. The plug of each probe when inserted calls up the correct readout of beats per minute or degrees centigrade as well as altering the internal electronic circuitry to suit that probe.

2. An apparatus according to claim 1, in which a combination of the 8 pins on each probe plug are connected together so that when inserted that probe is identified and the internal circuit altered to accomodate it with out the need for any manual switching controls.

3. An apparatus according to claim 2, wherein the gate terminals of certain bilateral switches are connected to the appropriate pins of the 8 pin socket so that when a plug is inserted conduction of one or more of these bilateral switches alters the internal circuit.

4. An apparatus according to claim 3, in which an inverter, whose input comes from one of the 8 pins of the input socket, controls a bilateral switch so that when no plug is inserted that bilateral switch conducts causing an indication of the battery condition on the L.C.D.

5. An apparatus according to claim 4, wherein said bilateral switch when conducting allows a fraction of the battery voltage to be fed to the display circuit so as to display the battery condition.

6. An apparatus according to any preceding claim, in which a direct path for battery charging through the said 8 pin socket is made via a diode connected from one of the input pins, normally carrying signals from a probe, to the battery.

7. An apparatus according to any preceding claim, in which any 3 of a 4 digit L.C.D. are driven by a digital voltmeter I.C. (Intergrated Circuit) and the fourth digit is made to display either a "C" for temperature or momentarily a small "o" on each heart beat.

8. An apparatus according to claim 7, in which the fourth digit of the L.C.D. is driven by exclusive/or gates whose inputs come from both the temperature control pins of the 8 pin socket, to generate the "C", and from a 200 ms. monostable oscillator triggered on the arrival of each heart beat to generate the "o".

9. An apparatus according to claim 8, in which the digital voltmeter I.C. receives a voltage proportional to the heart or pulse rate from a second order low pass R.C. filter whose input is supplied from the monostable oscillator.

10. An apparatus according to claims 7, 8 and 9 in which the voltage developped across the temperature probe when plugged in is fed via a bilateral switch, which is made conducting by it's plug, to the digital voltmeter I.C. that then displays the temperature on the L.C.D.

New claims or amendments to claims filed on 21 Oct. 1980.

Superseded claims 1 to 10.

New or amended claims:-

CLAIMS

1. An apparatus to monitor heart rate, pulse rate and temperature in which the units of the digital display read-out are automatically defined by which ever probe is pluged into the single 8 pin socket as well as indicating this by displaying either a small "o" for beats per minute or a large "C" for degrees centigrade.

2. An apparatus according to claim 1, in which patient safety and isolation from mains supply is achieved by having only one input socket, through which the battery may be charged instead of separate connections. This prevents both patient and external supply from being in contact without the need for complicated isolating circuitry.

3. An apparatus according to claim 1, wherein the gate terminals of certain bilateral switches are connected to the appropriate pins of the 8 pin socket so that when a plug is inserted conduction one or more of these bilateral switches alters the internal circuit.

4. An apparatus according to claim 3, in which an inverter whose input comes from one of the 8 pins of the input socket, controls a bilateral switch so that when no plug is inserted that bilateral switch conducts causing an indication of the battery condi-

5. An apparatus according to claim 4 wherein the said bilateral switch when conducting allows a fraction of the battery voltage to be fed to the display circuit so as to display the battery condition.

6. An apparatus according to any preceding claim, in which a direct path for battery charging through the said 8 pin socket is made via a diode connected from one of the input pins, normally carrying signals from a probe, to the battery.

7. An apparatus according to any preceding claim, in which any 3 of a 4 digit L.C.D. are driven by a digital voltmeter I.C. (Intergrated Circuit) and the fourth digit is made to display either a "C" for temperature or momentarily a small "o" on each heart beat.

8. An apparatus according to claim 7, in which the fourth digit of the L.C.D. is driven by exclusive/or gates whose inputs come from both the temperature control pins of the 8 pin socket, to generate the "C", and from a 200 ms. monostable oscillator triggered on the arrival of each heart beat to generate the "o".

9. An apparatus according to claim 8, in which the digital voltmeter I.C. receives a voltage proportional to the heart or pulse rate from a second order low pass R.C. filter whose input is supplied from the monostable oscillator.

10. An apparatus according to claims 7, 8 and 9 in which the voltage developped across the temperature probe when plugged in is fed via a bilateral switch, which is made conducting by it's plug, to the digital voltmeter I.C. that then displays the temperature on the L.C.D.

Printed for Her Majesty's Stationery Office by Croydon Printing Company Limited, Croydon, Surrey, 1981.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.